SIEMENS

# POLYMOBIL 10

SP

# Function description X050I

From wiring index A

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| Chapter | Page | Revision |
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| 0 | all | 02 |
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| 2 | all | 02 |

Page

1 POLYMOBIL 10 1 - 1

Generator concept. . . . . 1 - 1
Line connection . . . . . 1 - 1
Capacitor pack and charging circuit D950. . . . . 1 - 2
Main inverter D 960 . . . . . 1 - 2
Monitoring the inverter. . . . . 1 - 3
Single tank. . . . . 1 - 3
Starter circuit . . . . . 1 - 3
Actual value acquisition . . . . . 1 - 4
kV regulation . . . . . 1 - 4
kV monitoring . . . . . 1 - 4
Filament regulation . . . . . 1 - 5
Filament monitoring . . . . . 1 - 5
mAs counter . . . . . 1 - 5
Microcontroller unit . . . . . 1 - 6
Exposure circuit . . . . . 1 - 6
Interrupting exposure . . . . . 1 - 7

2 Changes as compared to previous versions 2 - 1

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## Generator concept

Circuit diagram X 050 I, page 2.

The POLYMOBIL 10 generator uses high-frequency inverter technology. A rotating anode is required due to its high output of 10 kW.

An 8-bit microcontroller located on printed circuit board D 915 controls the entire system. The control circuits, operating switches and display indicators are connected to this controller.

## Line connection

Circuit diagram X 050 I, page 2 and 3.

The POLYMOBIL 10 should be connected to a grounded outlet. The line voltage should range between 100 V and 240 V.

Power supply U2 ( 2 / 1 ) generates 12.5 V for the switch-on circuit, the contactors, relays and light localizer lamp.

The Polymobil is switched on via line filter Z1 ( 2 / 3 ) and fuses F 7 and F8. The LS contactor ( 2 / 4 ) energizes and supplies all additional circuits with voltage.

Power supply U1 ( 2 / 6) generates supply voltages of +5 V and +/-15 V required for the microcontroller, control circuit and transistors.

The power supply on board D 950 ( 2 / 1 ) charges the D 970 DC intermediate circuit.

During initialization of the Polymobil, either an alternating kV value is displayed or the center segment of the 7-segment display flashes.

As soon as initialization ends, the default values 60 kV and 10 mAs are displayed. These values can be freely selected and programmed using service program Pr. 5 at the customer's request.

If an error occurs during initialization, the error will be displayed on the control panel and initialization will be interrupted.

Polymobil is ready to operate when initialization has been successfully completed.

## Capacitor pack and charging circuit D950

Circuit diagram X 050 I, page 4.

The DC intermediate circuit on printed circuit board D 970 is fed by a forward controller (gain control) on D 950 (4 / 3). This constant current feed provides the advantage of maintaining the intermediate circuit at a constant voltage, independent of the line voltage. The lower the line voltage is, the longer it takes to charge the circuit.

For safety reasons, the intermediate circuit is automatically discharged when the Polymobil is switched off. The LS and CS contactors close the discharge circuit with resistors R3 and R4 ( 4 / 1 ). After approximately 10 minutes, the voltage has reached a non-hazardous level.

The capacitor bank on printed circuit board D 970 consists of 10 capacitors connected in parallel. A fast-blow, 20A fuse is connected in series to each capacitor. LED's indicate the charge status of each capacitor, independent of the status of the associated fuse. Therefore use: **CAUTION!**

## Main inverter D 960

Circuit diagram X 050 I, page 5.

The main inverter generates high-frequency energy packets for the high-voltage transformer. The microcontroller regulates the high voltage during exposure via the control frequency.

The main inverter on printed circuit board D 960 ( 5 / 3 ) consists of eight "Isolated-Gate Bipolar-Transistors", or IGBT´s.

By triggering two parallel-connected IGBT's across a bridge diagonal, a charge voltage flows through the primary serial circuit L1, C1 and the high voltage transformer in the X-ray tube single tank generator ( 5 / 3 ).

Subsequently, the charge voltage across serial capacitor C 1 is higher than the intermediate circuit voltage. This higher capacitor voltage forces a reverse voltage impulse across the antiparallel transistor-diodes and the intermediate circuit. The amplitude of the reverse voltage impulse is always smaller than that of the charge voltage impulse.

One cycle of oscillation is now complete and another energy packet can be transmitted in the opposite direction.

Two bridge diagonals are always required in one inverter since otherwise the magnetic flow in the iron core of the high-voltage transformer would reach a saturation state.

Additional energy packets can be transmitted by alternating control of the bridge diagonals. The maximum inverter frequency in Polymobil 10 is 14 kHz. This can be measured on printed circuit board D 915 at measurement point "REG" and "GRD", service program Pr. 7.

## Monitoring the inverter

A possible bridge short circuit is detected by monitoring the collector-emitter voltage Vce of every IGBT and, if necessary, the generator is blocked. The microcontroller then sends an error message to the control panel:

ERR 11 Inverter short circuit.

Refer to chapter 3 in the service instructions.

## Single tank

Circuit diagram X 050 I, page 6.

The inverter supplies voltage to the high-voltage transformer. The high-voltage transformer consists of two primary transformers connected in parallel. The tube voltage is generated on the secondary side via two voltage doubling circuits. The virtual neutral point of the high tension (S) is generated on board D900 by resistors R1/R2 (20K ohms each.)

On each of the anode and cathode sides are four 5 k ohm resistors connected in series. These resistors limit the ionization current if the tube short-circuits.

In addition, the filament transformer and the stator for the rotating anode are located in the tube housing.

The oil pressure switch ( 6 / 2 ) in the tube housing responds if the single tank becomes overheated during intensive use. The following error message is displayed:

ERR 09 Oil pressure in the single tank too high.

## Starter circuit

Circuit diagram X 050 I, page 9.

The starter circuit ( 9 / 6 ) is connected directly to the power line voltage. The stator currents run through two triacs (as zero transition switches) separated by an optocoupler, and are controlled by the microcontroller.

Two current transformers acquire both stator currents and conduct these to the microcontroller. The stator currents can be read on an oscilloscope at measurement points I 1 and I 2 ( 9 / 2 ) on board D 915.

If the required values are not attained, the error:

ERR 10 Rotating anode not started,

appears on the control panel.

The rotating anode is slowed down by means of DC current through the main winding of the stator.

The line voltage is acquired by an optocoupler (J 12) ( 9 / 5 ) and the start-up and braking times are adjusted depending on whether 110 V or 230 V are present.

## Actual value acquisition

Circuit diagram X 050 I, page 6.

The momentary tube voltage kV ACT is acquired via a frequency compensated voltage divider of ( 10 000 : 1 ). This kV ACT value can be read out on an oscilloscope on board D 915 ( 6 / 3 ).

The tube current IR is measured by two resistors of 10 ohms each on board D 900 +/- symmetrical to zero volts. This value can be measured and read out on the oscilloscope on board D915. The mAs jack is located on board D 900.

## kV regulation

Circuit diagram X 050 I, page 7.

The digital / analog converter (J 17) ( 7 / 3 ) converts the kV-NOM value from the microcontroller (J 31) into an analog value. The microcontroller monitors these analog nominal values which can also be read out on the oscilloscope at measurement point KVS ( 7 / 3 ).

The kV actual value is acquired via the voltage divider measurement on D 900 and monitored by the microcontroller. The kV ACT value can be measured and recorded on the oscilloscope on board D 915 at measurement points KVP, KVN and KV ( 7 / 1 ).

KV-NOM and kV-ACT are compared in the PI regulator (J10). The output signal of this regulator controls the voltage frequency converter (J3). The output frequency can be measured on the oscilloscope at measurement point REG ( 7 / 1 ) on board D 915.The pulse patterns for the inverter diagonals are subsequently generated.

The microcontroller controls the U/F converter (J3) on board D 915 ( 7 / 1 ), measurement point TRIG. The exposure is switched on and off via this component.

## kV monitoring

The kV ACT value is continuously compared with the maximum acceptable kV limit value in the threshold components (J 12) ( 7 / 2 ). When the kV threshold is exceeded, or when the amplitudes of KVP and KVN are different, the generator is immediately blocked.

The inverter is disabled in response to the following errors:

| | |
|---|---|
| Bridge short circuit | SCM |
| kV-MAX | KVM |
| Tube current error or | |
| Maximum filament current | JIM |

## Filament regulation

Circuit diagram X 050 I, page 8.

The tube filament is controlled via a transistor half-bridge on board D 925 ( 8 / 1 ) and the filament transformer in the single tank.

The analog/digital converter (J17) ( 8 / 2 ) converts the nominal value of the filament or tube current from the microcontroller (J 31) into an analog value. The microcontroller monitors this analog NOMINAL value which can be measured on an oscilloscope at measurement point IRS ( 8 / 3 ).

The actual value of the filament current is acquired via the current converter (TF3) on D 925 and monitored by the microcontroller as well. The filament ACTUAL value can be measured on an oscilloscope on board D 915 at measurement point IH ( 8 / 3 ).

I-Fil-Nominal and I-Fil-Actual are combined and forwarded to the PI regulator (J10). The output signal of this regulator drives the voltage frequency converter (J2). The output frequency can be measured on an oscilloscope at measurement point CAL ( 8 / 2 ) on board D 915. This sequence of pulses controls the filament inverter and also the current through the filament.

The tube current ACT value is acquired on board D900 ( 8 / 4 ). It is monitored by the microcontroller (J31) via amplifier (J4) ( 8 / 4 ) and also used for regulation. The frequency ACT value can be measured on the oscilloscope on board D 915 at measurement point F1. This frequency is used in the mAs counter to switch off the exposure.

The actual tube current IR is used for regulation during the exposure.

The voltage for the filament inverter in the intermediate circuit is automatically adjusted to the line voltage. At 230 V the intermediate circuit rectifier (V 25) acts as a standard full-wave rectifier. At 110 V line voltage, it becomes a voltage doubling circuit via the AVS (J 13) ( 8 / 1 ).

## Filament monitoring

If the filament current IH or the tube current IR exceeds the maximum acceptable value, the threshold components (J12) will respond on board D 915 ( 8 / 5 ) (measurement point JIM). The generator is blocked and the corresponding error codes will be displayed on the control panel. Refer to chapter 3 in the service instructions.

## mAs counter

The tube current acquired on board D 900 ( 8 / 4 ) is forwarded to the voltage frequency converter (J 1) ( 8 / 5 ) on board D 915. This converter generates a proportional frequency with the ratio:

50 mA => 1 V corresponds to 16 kHz.

The output pulses can be measured on the oscilloscope at measurement point F1 on board D 915 ( 8 / 5 ). The pulses are digitally integrated in the microcontroller and the exposure is ended when the mAs NOMINAL value is attained.

## Microcontroller unit

Central monitoring and control is processed via an 8-bit microcontroller ( 10 / 3 ). The controller communicates via a bus system (J 31) with:

| | |
|---|---|
| (J 32) | EPROM, containing the firmware, |
| (J 33) | RAM, |
| (J 24) | Display controller. |

High voltage, filament and tube current are controlled via parallel port inputs and outputs.

In addition, several interrupt inputs and an internal watchdog are available via the microcontroller. The watchdog monitors the software functions in Polymobil 10. There is no external signal or display for the watchdog on board D 915.

## Exposure circuit

Circuit diagram X 050 I, page 10.

**Preparation:**

When selecting preparation -ZB- on the exposure release switch S 27 ( 10 / 2 ), an interrupt is generated in the microcontroller (J 31).

If the microcontroller does not block the function via an error code, the:

- tube filament is heated to the level required for the exposure and
- the rotating anode accelerates to the nominal rotation speed.

The display controller (J 24) on board D 915 controls LED V 22 -ZB.

After a preparation time of approximately 2 seconds the exposure is released.

If the preparation time takes longer than 15 seconds the error:

| | |
|---|---|
| ERR 22 | maximum preparation time exceeded, is displayed. |

**Exposure release:**

When the main contact -HK- is pressed on the exposure release switch S 27 ( 10 / 2 ), the main inverter is released by the micro controller - measurement point: TRIG ( 7 / 4 ) and the exposure begins.

**Exposure shutoff:**

When the mAs counter reaches the mAs NOMINAL value, the exposure is ended by the microcontroller.

## Interrupting exposure

An exposure can be interrupted by one of the following events:

The time limit (T-Limit) is reached before the mAs counter reaches the NOMINAL value. A safety timer ends the exposure and the following error appears:

ERR 17 maximum exposure time.

>> T-Limit = 2 x theoretical exposure time + 100 ms <<

kV-ACT > kV-MAX. As soon as this error occurs, the inverter is immediately blocked and the error message:

ERR 12 kV-MAX, is displayed.

I TU> I TU-MAX. As soon as this error occurs, the inverter is immediately blocked and the error message:

ERR 13 I-MAX, is displayed.

If the exposure is prematurely interrupted manually, the error:

ERR 18 Exposure not ended, is displayed.

Refer also to the service instructions, chapter 3.

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# Changes as compared to previous versions 2 - 1

The entire document was restructured and revised.

SIEMENS-Getafe / Casero
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